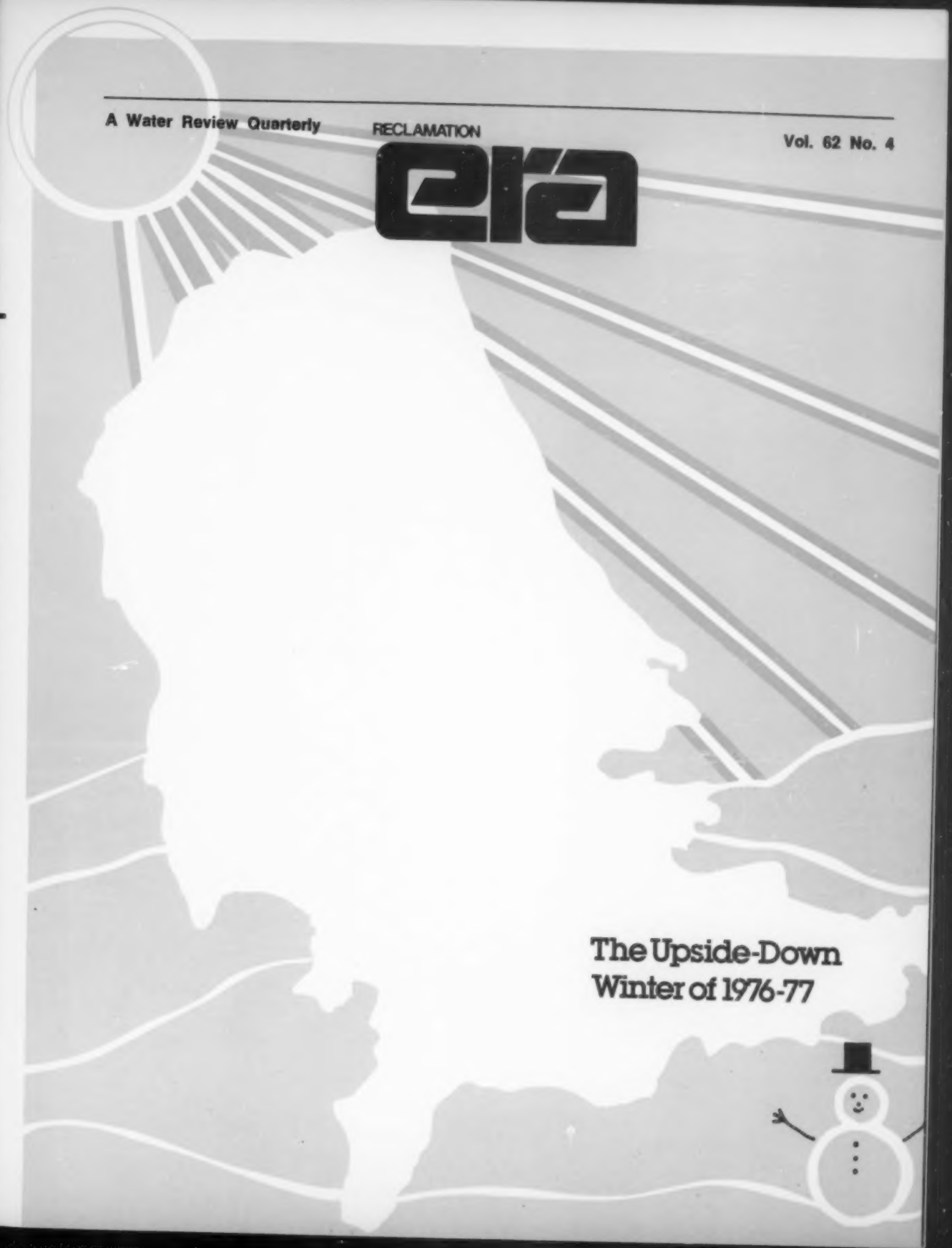
A Water Review Quarterly

RECLAMATION

era

Vol. 62 No. 4



The Upside-Down Winter of 1976-77

RECLAMATION

era

Winter 1976
Vol. 62 No. 4

United States
Department of the Interior
Cecil D. Andrus, Secretary

Bureau of Reclamation
R. Keith Higginson, Commissioner

Editor
Kathy Wood Loveless

Letters to the editor should be addressed to: Editor, *Reclamation Era*, Code 147, Bureau of Reclamation, 18th and C Sts., NW., Washington, D.C. 20240.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price: $1.05 for single copy, $4.00 for annual subscription ($1.00 additional for foreign mailing).

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Cover

This upside-down winter brought snow to Miami, a thaw in Alaska, and emphasized the need for irrigated agriculture.

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director, Office of Management and Budget, February 3, 1975.

IRRIGATION: Put to the Test

The winter snow and rains haven't come to California, gripping the fertile farms of Central Valley in what may prove to be the worst drought ever recorded. In the Colorado River Basin, the snowpack which feeds life-giving water to streams and tributaries of that arid region is the scantiest in years.

A freakish winter freeze in southern Florida has severely damaged much of the winter vegetable and fruit crop; and in the Midwest farm belt, frozen ground is preventing moisture from penetrating the bone-dry soil, giving rise to concern over potentially serious spring planting problems.

This upside down winter of 1976-77—which has already brought snow in Miami and a January thaw in Alaska—underscores the enormous value of the Nation's investment in irrigation facilities.

For despite the aberrant weather, Reclamation-irrigated lands in the Southwest are yielding an ample supply of fresh

A 40-year career civil servant, Gilbert G. Stamm served as Commissioner of Reclamation by appointment of the President of the United States from May 16, 1973, until February 12, 1977.

by Gilbert G. Stamm

The winter thaw in Anchorage, Alaska, resulted in barren trails where the Fur Rendezvous women and junior dog races are usually held. Photo courtesy Anchorage Times.

winter produce to help hold down prices in markets all over the Nation. Reclamation operation in California, Arizona, New Mexico, and Texas help produce over $600 million worth of vegetables and $500 million worth of fruit annually. The irrigation facilities built under the Federal program assure a continuing supply of fresh winter lettuce, asparagus, tomatoes, onions, peppers, green vegetables, and citrus fruit for America's dinner tables.

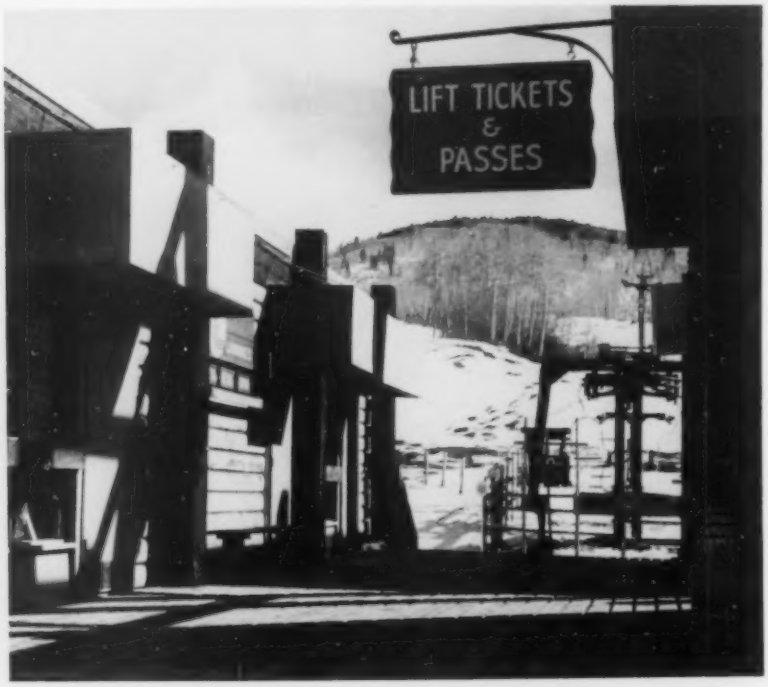
And even with the prospect of serious drought for much of the West this summer, there will still be substantial crop production thanks to water stored behind federally built dams.

Reclamation continues to play a vital role in the Nation's food chain. The 9.3 million acres of farmland irrigated from water storage in and delivered through Federal water control and management systems in the contiguous 17 Western States produced $4.4 billion worth of crops in 1975—including about one-third of the Nation's fresh and processed vegetables and nearly 20 percent of the fresh and processed fruit. Enough food was produced on Reclamation-served land to feed 36½ million people for the year.

The national investment in Reclamation facilities continues to pay off year after year—season after season. So when disaster strikes, as it did with the winter freeze in southern Florida, the production of winter citrus fruit and vegetables from land irrigated by Reclamation helps soften the impact from the crop-damaging freeze.

Empty lift lines and barren hills testify to the strange winter weather.

This summer, in the face of a serious drought potential, Reclamation will once again prove its worth. Even with the specter of rationing—which is being imposed in California because of the continuing drought—more crops will be produced this year, thanks to the Central Valley Project, than would have been possible without the large-scale water resource developments in operation today because of the vision and foresight of leaders 25 years ago.



Poor business for Brighton Ski Bowl, Utah, could mean a water shortage for crops.

The same is true for other areas of the 17 Western States. Despite the scant snowfalls in the mountains that feed the headwaters of the Colorado, storage in Utah's Lake Powell and Lake Mead on the Nevada-Arizona border is sufficient to supply irrigators along the 1,400-mile river this summer.

Even the Pacific Northwest, which normally has an abundant water supply, is experiencing what may become the lowest water year in its history, but the carryover storage in Reclamation reservoirs will forestall what otherwise might have been a disastrous crop-production year.

It is times like these that put the water regulation and management systems to their severest test—and the systems are working exactly as intended—to bring stability and enhancement to arid regions through the wise development and use of scarce but renewable water supplies.

Consider the record. In the 70 years since crop statistics were first compiled, western irrigated land served by Reclamation facilities has produced crops valued at more than eight times the total investment in those facilities. The benefits from the program are real, permanent, and growing. Of this, we are continually reminded when nature pulls its punishing tricks.

Water
Quiz

Canyon Ferry, Yellowstone Canyon, Boulder City Canyon, or Glen Canyon?

1. Which of the following is a 20-mile canyon gouged 1,200 feet deep through soft, volcanic rock?
(A) Canyon Ferry
(B) Yellowstone Canyon
(C) Boulder Canyon
(D) Glen Canyon

2. Medicinal waters come from springs which emerge naturally or from waters which have been artificially tapped.
(A) True
(B) False

3. Ground water must be accurately tested along with the ground itself when large concrete buildings or extensive pipe lengths are to be built or laid. The water which comes into contact with concrete structures must be colorless. Yellowish or brownish water contains _____ and _____ which are highly detrimental to concrete.
(A) Magnesium sulphite and chloride
(B) Rust and Sulphur
(C) Hunins and Hunic Acids
(D) Chloride ion and Lime-aggressive CO_2

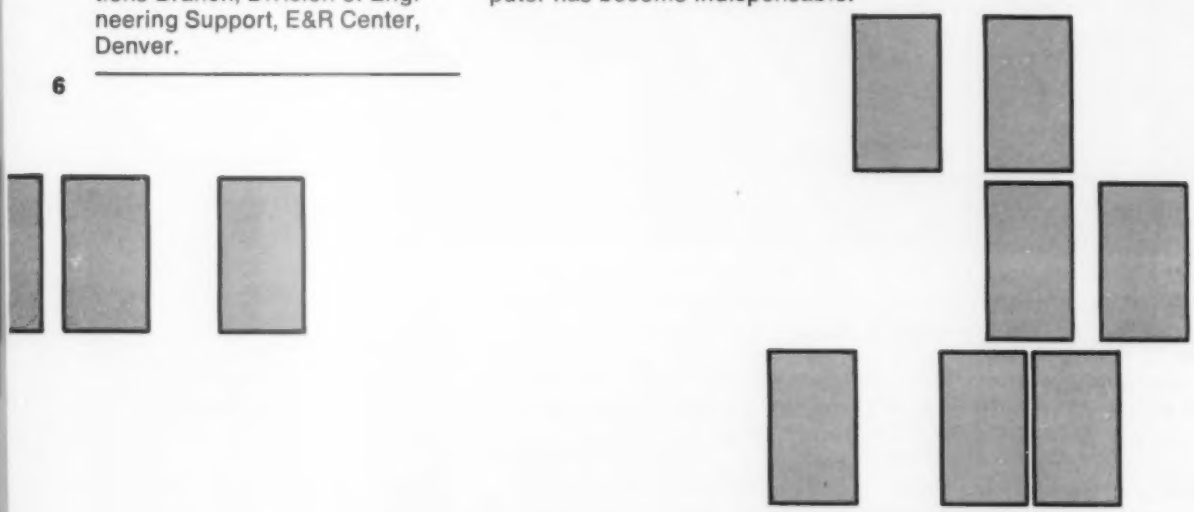
4. The human body is comprised of approximately three-fourths water.
(A) True
(B) False

5. The impurities in a city's water supply must be removed by:
(A) Filtration
(B) Precipitation
(C) Chemical neutralization
(D) All of the above
(E) None of the above

Answers to Water Quiz on back inside cover.

Don't Fold, Spindle or Dial the Wrong Number

by Jim Joslyn



The electronic computer—where would we be without it in today's complex, fast-paced world?

Scientists, engineers, and environmentalists feed computers voluminous quantities of data on natural resources to help them plan energy conservation and development for the future. City planners evaluate computer-generated traffic projections to aid in the rehabilitation of a core city. The television weatherman explains the impending storm with a space photograph taken from a satellite whose design, orbit, and transmission function are computer controlled.

Somewhat more dear to our hearts than weather pictures are our paychecks. Many of us are paid by computer. These electronic accountants calculate our vacation time, deduct our taxes, and even deposit what is left.

Then they dun us.

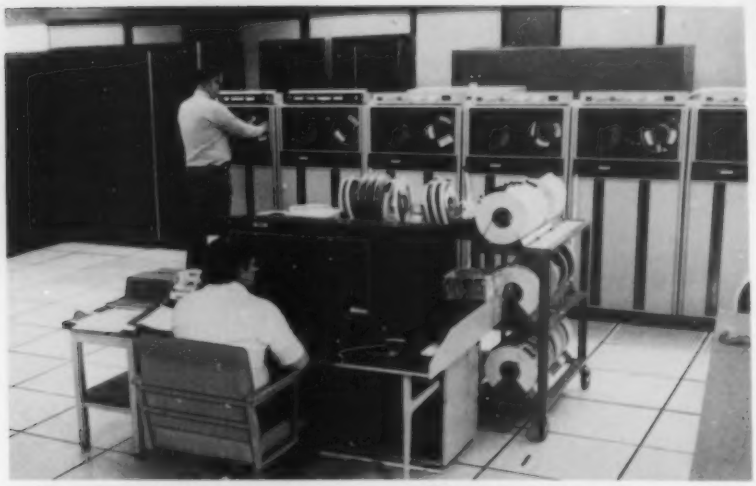
Who can ignore those neatly-printed, return-this-portion-with-payment statements that filter through the mail around the first of each month? And it's all done easier and faster with a computer.

We have come to take computers for granted. We find innumerable applications for them without realizing the tremendous impact they have on our lives. Since military and research needs fostered the first crude electronic computer machines only a brief 35 years ago, the computer has become one of the most important tools for sustaining and enhancing modern man's existence. To the water resources field and the Bureau of Reclamation, the computer has become indispensable.

For several years Reclamation relied on a variety of computers located in different cities to aid in carrying out its water resources programs. As the demand for energy and water increased in the West, the Reclamation program and data processing needs also grew. A comprehensive study was made in the early 1970's to determine how best to deal with the ever-increasing data processing requirements.

The study resulted in a new era for Reclamation's data processing. In 1974 a large-scale computer coupled with an extensive telecommunications network replaced the old setup that consisted of several scattered and different model computers, and services supplied by private vendors. In 1976 computer capacity was expanded to further increase the capabilities of this centralized system.

Jim Joslyn is an editor-writer, Technical Services & Publications Branch, Division of Engineering Support, E&R Center, Denver.



Reclamation's central computer at the Engineering and Research Center in Denver

The centralized system is located at the Engineering and Research Center in Denver. The telecommunications network links more than 55 western cities and offices, as well as the Office of the Commissioner in Washington, D.C., to the central computer.

The system has vastly improved Reclamation's computer operating efficiency, saving dollars and manhours. It presently serves all of Reclamation's data processing requirements, and excess capacity is made available to other Interior Department agencies.

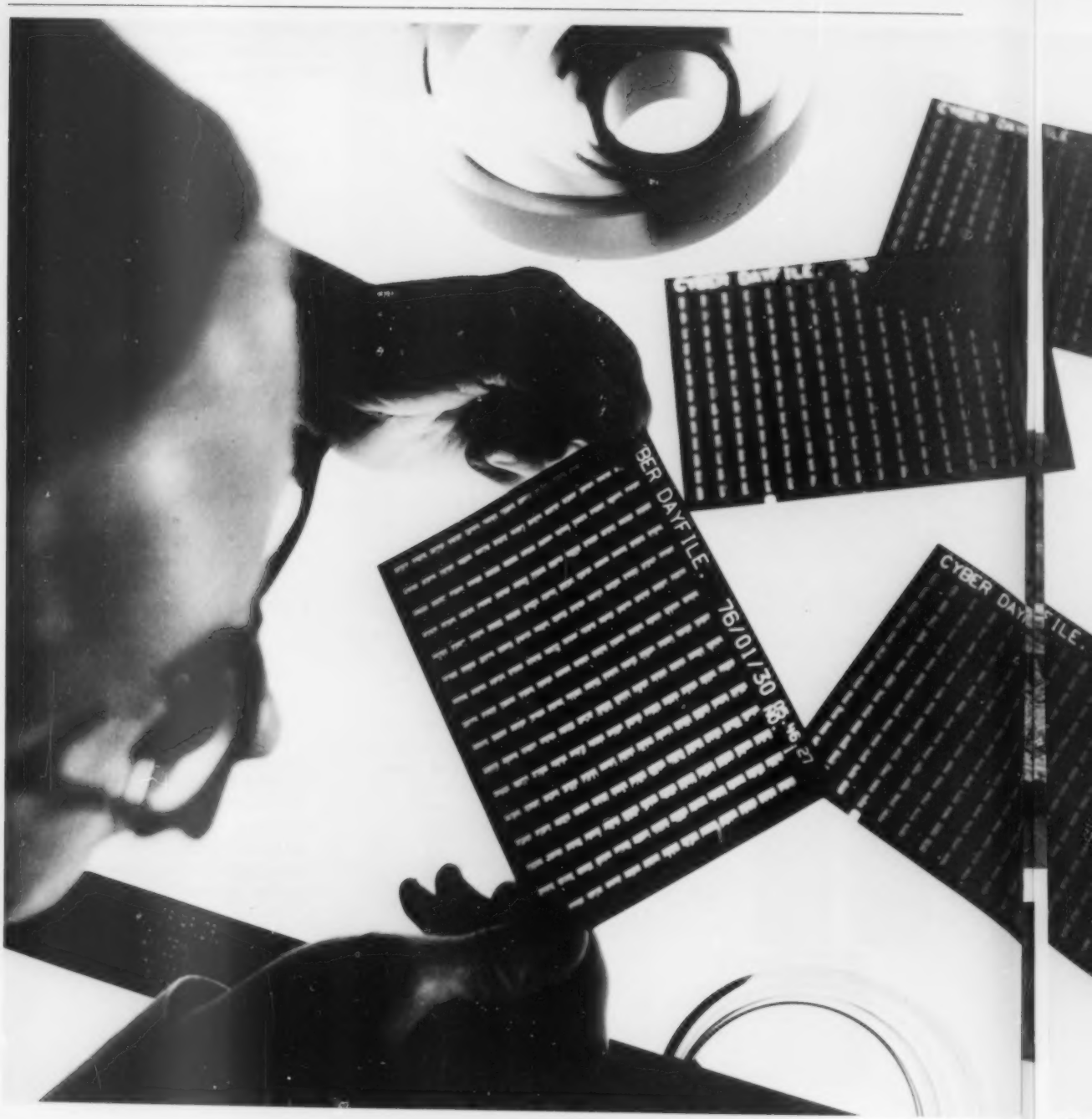
The central computer system is one of the fastest and most sophisticated in the West. It was developed specifically to meet Reclamation's multiprocessing, multiprogramming, and time-sharing requirements.

The computer's multiprocessing capabilities allow it to accomplish many tasks at once. An average of more than eight different jobs can run at one time. These jobs may be scientific, engineering, or administrative and may originate from any remote terminal on the telecommunications network.

The speed at which the central computer operates is extraordinary—up to one million multiplications in one second. Three central processors are used primarily for mathematical computations while peripheral processors handle input/output functions.

The system has vastly improved Reclamation's computer operating efficiency.

The main memory of the expanded computer system can hold 229,000 words of data (each word equals 10 alphabetic or numeric characters). An extended core storage contains an additional ½ million words. Data between the main memory and extended core storage are transferred at the rate of 2½ million words per second.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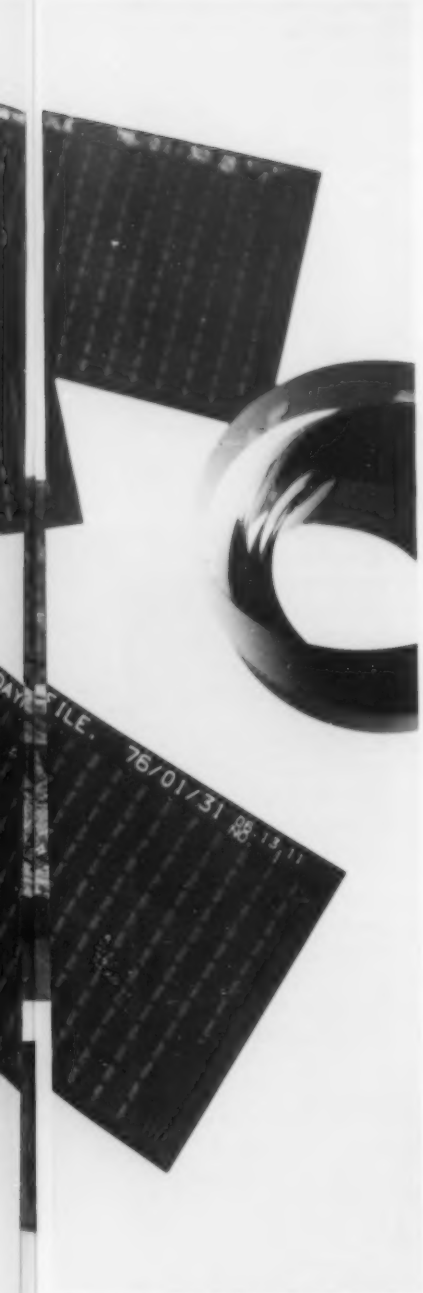


These six-inch strips of microfiche store information equal to more than 200 pages of printed information.

A major portion of the central computer system's workload originates from remote terminals on the telecommunications network at field offices and at the Engineering and Research Center. Its operation is similar to calling your aunt in Denver. The conversation is a little different though.

Each remote terminal has a conventional telephone hookup. When the proper number is dialed, a line is opened to the central site. The data are entered in the remote terminal, usually through a keyboard, and then transmitted through the telephone lines to the central site. The high-speed data transmission allows field, Denver, and Washington office personnel almost immediate access to the computer system. The remote terminals are most often similar to teletype machines but they may be as sophisticated as moderate-sized computers. Currently about 300 terminals are tied to the network and the number is expected to increase.

The central computer-telecommunications arrangement permits programs developed at any Reclamation office to be used by any other Reclamation office on the network without conversion, duplication of effort, or loss of time. Much of the technical and administrative data used by Reclamation is stored at the central site and is available to all qualified users on the network.

Ultimately, much of the information processed by the central system reaches the customer in printed form. At the central site, four printers can each generate 1,200 lines of print per minute (each line is 132 characters long). In addition, some information is displayed on the cathode ray tube screens that are part of the remote terminals, some take the form of graphics from the automated plotter and still other data are recorded on film or microfiche by the microfilming system.

The capability of the microfilm system to reduce storage and paper requirements is evidenced by its microfiche output. One microfiche is a 6-inch length of 105 mm film. On this small piece of film can be placed information equal to more than 200 pages of printed information. And this microfiche can be stored in a space approximately 1/10,000 the size of that required for print.

The automated plotter is used to plot a variety of computer-generated illustrations such as contour maps and cross sections. Like the microfilm system, the plotter has its own minicomputer which enables it to retrieve, store, and manipulate data and control its plotting head. It can produce a drawing in 15 minutes that would take 2 or more days if done by conventional methods.

The centralized computer system, like Reclamation, is not an end in itself. Both are meant to serve people—in this case the people of the West. Increasing water and energy demands have dictated a more judicious use of our natural resources. The computer system aids Reclamation in developing, conserving, and protecting those resources.

Irrigation management, for example, uses the computer to estimate irrigation water requirements. This results in improved service to the farmer, increased efficiency of farm operation, and reduced cost and waste. Unchanging field data such as farm size and soil type are initially collected. Then variable climatic data, rainfall for instance, are gathered and transmitted from remote terminals to the central computer. The computer analyzes the factors and determines the irrigation schedule for a 2-week period. This information is given to the farmer. Both crop yield and farm income can be increased, while a more effective use is made of the water. (See "Irrigation Management Services," in *Reclamation Era,* Spring 1976, page 26).

As the demand for clean water increases, controlling the salinity in our rivers becomes more critical. On the Colorado River near Yuma, Ariz., Reclamation is responsible for the design and construction of the world's largest desalting plant. The computer is, of course, instrumental in the design of the plant. Perhaps even more important, after the plant is completed, the computer will calculate the amount of "cleansed" water that must be added to the river to lower the salinity level to acceptable limits. Colorado River water will then be more useful to farmers in Mexico.

Earthquake engineering in dam design is an important computer application. Where optimum sites for dams are located in areas of seismic activity, designs for the dams are subjected to extensive computer earthquake analyses. The objective is a design that will overcome the adverse effects of potential major earthquakes.

Computers are an essential part of the Reclamation research program. New techniques and methods are frequently developed with the aid of computer-simulated models. One important research program, Project Skywater, seeks to remove the uncertainties in cloud-seeding technology. This program relies heavily on computers to collect and evaluate weather data as well as to determine when conditions are best for cloud seeding.

Irrigation management uses the computer to estimate irrigation water requirements.

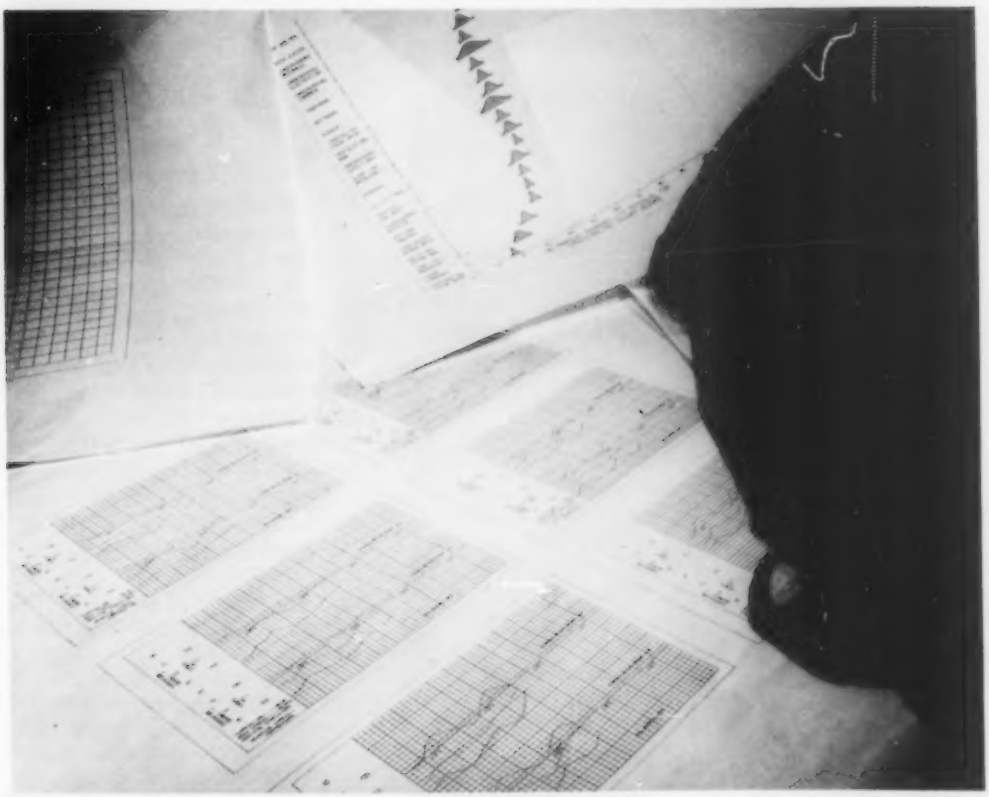
Though data processing touches almost every facet of the Reclamation program, the staff necessary to develop, operate, and maintain the total system is relatively small . . . approximately 175 people are responsible for the effective and efficient operation of the Bureau-wide computer and the telecommunications network.

About half of the data processing staff is located at the central site in Denver. The remainder is in Reclamation's seven regional offices and the Washington office. These people include scientists, administrators, engineers, systems programmers and analysts, equipment and communications specialists, computer operators and technicians, keypunch personnel, and data processing managers.

In addition to data processing personnel, more than 1,000 other Reclamation employees have been trained to use the computer system. These people are responsible for planning, designing, and constructing Reclamation water facilities throughout the West. Engineers, meteorologists, personnel specialists, accountants, biologists, economists, and chemists represent only a few of the technical and administrative disciplines that use the system.

With the central computer and the telecommunications network, Reclamation data processing has reached a significant plateau. Whether you are an employee of the Bureau, a computer user, or just live in the West, chances are that Reclamation and its centralized computing system have provided you benefits from our renewable water resources.

Darrell Webber, Chief of Reclamation's Division of Data Processing, explains the telecommunications network.



The automated plotter can produce a drawing in 15 minutes that would take two or more days if done by conventional methods.

CLEAN WATER FLOWS UP, NOT DOWN

by Adelaide Hawn

Editor's Note:
Although the technique explained in this article is not one used by Reclamation, we thought it is one in which our readers would be interested.

Many people and governments are unaware of the urgency to reuse water.

The critical problem of clean water, particularly in arid nations, where supply is short, may be aided by a kind of upflow sand filtration system now unavailable to most public water and sewerage works systems.

Citing the urgent need to reuse a nation's water supply, which is a finite resource, an Iranian scholar and recent recipient of a doctor of philosophy degree in civil engineering from Tulane University points out that countries such as his homeland are expecting an increased population rate in the years ahead.

"However," explains Fereydoun Ittihadieh, currently a faculty member at the University of Tehran, "many people and governments are unaware of the urgency to reuse and reuse water if they are to have sufficient amounts not only for their industrial purposes but for clean water to drink."

Ittihadieh, considered an expert on water recycling processes, has spent the past 3 years in the United States researching a process for reusing water at minimal cost and maximum efficiency.

While the technology of what is termed "upflow sand filtration" has been used in solving industrial water problems in some areas of the United States, it has still to reach the nations which will be desperately affected when clean water is gone.

"In Tehran, Iran's capital city, as in many other large cities," he says, "there will be a water shortage and the situation is going to get worse as our population, now at over three million, is rapidly growing. Our water supply can only support a population of five million, maximum."

The sand filtration process may become highly applicable for Tehran, which is sitting on top of a vast sand and gravel foothill formation.

"And this is why the Iranian Government and the University of Tehran are expediting specialist training and expertise through programs such as Tulane's graduate engineering curriculum," he adds.

The process Ittihadieh has been researching is cheaper and more readily accessible than the conventional downflow filtration process requiring large holding basins and the expenditure of extensive capital.

The upflow sand filtration process is a reversal of the traditional system in waterworks

which operates by gravity. It allows for dirty water to enter the bottom of a unit, proceed upward by pumping into graded layers of large-to-fine sand, and emerge as water devoid of its suspended solids. Some coagulating agents are generally used in sand filtration.

The upflow sand filtration process is a reversal of the traditional system in waterworks which operates by gravity.

In addition, the Iranian civil engineer has shown in field work that his filter model is a far less complicated hydraulic system which may be automated easily and economically.

Ittihadieh says that upflow sand filtration is new in terms of domestic wastewater treatment methodology and is therefore not being used to its fullest extent. The research he has been conducting is an engineering feasibility study for water treatment. The results may be applied to rural as well as to urban wastewater collection systems and at specific spots within a city. It may be used separately or integrated into a sewage treatment plant.

Explaining that wastewater treatment systems design must be varied according to climate, population, dietary habits, and other factors, he cites that it is difficult to sell ideas about innovating items pertaining to public works. And innovation is the challenge of sanitary engineers and public health specialists today in most areas of the world.

Demands for improved methods in wastewater treatment to prevent pollution and to expand water reuse practice are constantly increasing," says the Iranian, "and its need is being strongly felt, particularly in the field of domestic use."

Following his Tulane graduation, Ittihadieh returned to Iran where his 300-page dissertation will be used as a guide in wastewater treatment for further research in his country.

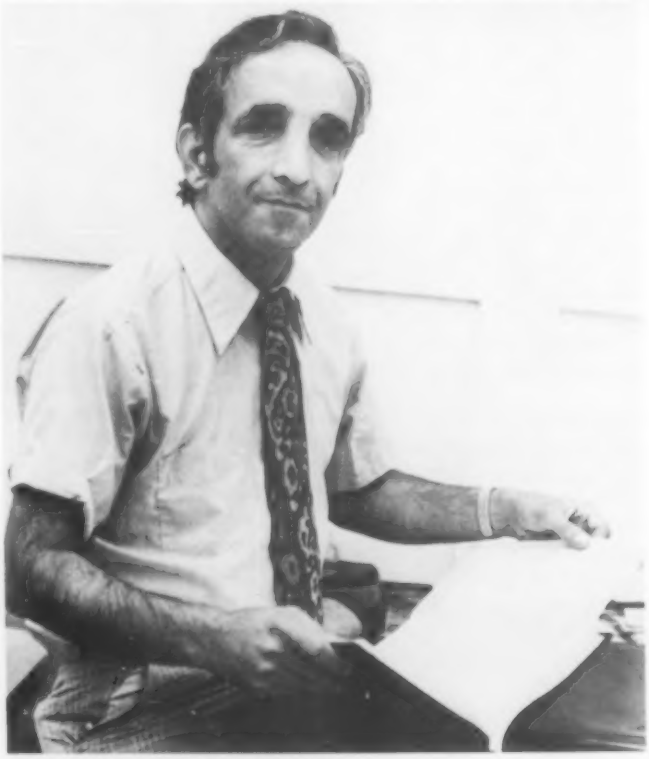
Additionally, it will serve as a basis for expanded curricula at the University of Tehran, the oldest university in Iran and mother to all of the institutions of higher education in that nation.

"Hopefully," he says, "students coming from surrounding nations, where soil and climate are also arid and sandy, may profit from the extensive study made on the upflow process."

The World Health Organization and foreign governments are investing billions of dollars studying methods and implementing systems for cleaning up dirty water.

This is being done to create a systematic control in water and sewerage works to ensure the use and reuse of water safely and economically. ea

Adelaide Hawn is the news editor, Office of University Relations, Tulane University, New Orleans, La.



Iranian scholar, Fereydoun Ittihadieh

Reclamation Library

Reclamation Annual Report Available

Since 1905, western farms irrigated by Reclamation projects have producd food, fiber, and forage worth nearly $50 billion—more than eight times the total $6 billion invested in facilities constructed under the Bureau program.

These statistics are contained in the *Water and Land Resources Accomplishments for 1975,* the annual report of the Bureau of Reclamation which is now available. Copies can be obtained from the Publications Branch, Code 910, Bureau of Reclamation, 18th and C Sts. NW., Washington, D.C. 20240 or call (202) 343-4684.

Water and Land Resources Accomplishments for 1975

Report on Teton Dam Failure Available

Immediately following the failure of Teton Dam on June 5, 1976, former Secretary of the Interior Thomas S. Kleppe and former Governor of Idaho, now Secretary of the Interior Cecil D. Andrus joined in ordering an investigation of the cause of the failure. They established an Independent Panel to review the cause.

After 7 months of investigation, the panel members, headed by Wallace L. Chadwick, sent a letter to Messrs. Kleppe and Andrus concluding: "(1) that the dam failed by internal erosion (piping) of the core of the dam deep in the right foundation key trench, with the eroded soil particles finding exits through channels in and along the interface of the dam with the highly pervious abutment rock and talus, to points at the right groin of the dam, (2) that the exit avenues were destroyed and removed by the outrush of reservoir water, (3) that openings existed through inadequately sealed rock joints, and may have developed through cracks in the core zone in the key trench, (4) that, once started, piping progressed rapidly through the main body of the dam and quickly led to complete failure, (5) that the design of the dam did not adequately take into account the foundation conditions and the characteristics of the soil used for filling the key trench, and (6) that construction

activities conformed to the actual design in all significant aspects except scheduling."

The report was released simultaneously in Idaho and Washington, D.C. on January 6, 1977.

Copies of the *summary report* may be obtained by writing to the Bureau of Reclamation, Engineering and Research Center, Code 922, Denver, Colo. 80225.

Copies of the *full report* are available for $9 from the above address or from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Book Review

Spencer, Donald A., ed. *Wintering Bald Eagle.* 170 pp, 1976. Published by the National Agricultural Chemicals Association.

In this book Donald A. Spencer offers an insight into the willingness of some Americans to assure the future of the eagle. The book describes the eagle's adapability, imagination, innovativeness, and courage; and it emphasizes the value in saving the eagle.

Wintering Bald Eagle.

Many bird observers supplied information on the winter migrant Bald Eagle. Specific departures and arrivals of the eagle in certain States are noted as are wintering locations and the numbers of eagles.

Spencer discusses the benefits to the eagle of some technological progress such as hydroelectric plants. Hydroelectric plants provide heat which prevents the freezing of water and they kill some fish, providing the eagles with food.

The feeding behavior of the eagle in States such as: Montana, Idaho, Illinois, Oklahoma, Texas, South Dakota, Washington, Utah, and Kansas are discussed by ornithologists. Findings on the eagle's feeding behavior differ according to the State.

Methods of tracking the eagles also vary. Some of these methods include attaching bands to the bird's leg to identify its previous location, attaching a colored disc to the edge of the bird's wing, and a more sophisticated method is strapping a radio transmitter to the bird and tracking the signals.

—Reviewed by
Anthony S. Meadows

A Reclamation Muzzle-loading Rifle Enthusiast

by Sue DeShazo

With the fading sounds of the battles of the Civil War, the sounds of the muzzle-loaded rifles and the smell of black powder smoke died also. Not quite. Although the muzzle loaders may not be the official martial arms of today, thousands of blasts still ring out when members of the National Muzzle Loading Rifle Association (NMLRA) gather for a shoot.

President of the 20,000-member organization is Alfred W. Hill, a Bureau of Reclamation environmental specialist in Amarillo, Tex. A career employee with 20 years of service, Hill has held his present position since July, 1971. Prior to that he served with the Fish and Wildlife Service in Vicksburg, Miss.; Fort Worth, Tex.; Tulsa, Okla.; and Washington, D.C.

Hill earned a B.S. degree in animal husbandry from Oklahoma State University and completed 50 hours of graduate work in wildlife conservation. He served with the U.S. Army in Louisiana and Japan and worked for the New Mexico Department of Game and Fish for 2 years before joining the Federal service.

Sue DeShazo is a public information specialist in the Southwest Region, Amarillo, Tex.

The NMLRA has members in all 50 States, the District of Columbia, and Canada plus some other foreign countries and U.S. territories. Even the newest State, Hawaii, has eight members, but statistics don't reveal where they learned the primitive art. As expected, Indiana, the home of the headquarters, has the largest number of members—over 3,000.

Headquarters for the association is 480 acres of land in the beautiful and historic Laughery Creek Valley, near the quiet, picturesque town of Friendship, Ind. Facilities include Walter Cline Range and more than 900 feet of covered firing line, a clubhouse, and over a thousand designated camping sites with electricity and sanitary facilities available nearby. During Hill's tenure as president, a new office building was built and the late 1800-era farmhouse, used as an office, is now a museum.

Hill believes muzzle-loading rifle and shotgun shooting is the fastest growing shooting sport in the country. History and the American heritage are important to muzzle loaders. Authentic clothing, cooking, handcrafting, and, of course, firearms testify to this fact. Many of the members make all their equipment including their firearms. "We like to feel we are preserving for tomorrow the pioneers' arms craftsmanship and skills which bore freedom and liberty," says Hill. "This makes it particularly important that the understanding of the sport, the skills, and the history of muzzle-loading firearms are passed on to the younger generation."

The bicentennial year created increased interest in muzzle loading. Many communities and

Many of the members make their own clothing and firearms.

organizations throughout the country included muzzle-loading demonstrations and shooting matches in celebration plans. The NMLRA hosted special bicentennial championship matches and events at its

The bicentennial year created increased interest in muzzle loading.

national range in the spring as well as national matches in the late summer.

At these annual championship and national matches, approximately 2,000 shooters participate in an average of eight events each. Some of them may fire as many as six different guns—each specially built for one of the more than 20 aggregates in which shooters participate.

Two types of rifles are fired in basic competition—the flintlock, a revolutionary firearm with the powder charge set off by flint striking steel, and the percussion, a more progressive firearm developed in the early 1800's

which uses a small cap for its ignition system. The rifles may vary in caliber, weight, length, and type of sights, but all are muzzle loaders. Flintlock rifles can be fired in percussion competition, but the reverse is not true since the percussion firearm is considered more advanced.

The more popular events in flintlock and percussion competition are off-hand, or shooting from a standing position; cross stick, shooting at a buffalo target with the gun barrel resting on two crossed sticks; bench rest, shooting from a sitting position with the rifle resting on blocks; slug gun, a sharpshooter loaded with an elongated bullet; and musket, replicas of military issue which fire a minie-ball.

Stationary targets are used in all of the rifle and pistol competitions while moving targets are used when shooting trap and skeet with both flint and percussion shotguns. In addition to the some 90 conventional matches scheduled, there are several primitive fun-type matches such as splitting-the-ball on the axe, tomahawk throwing, and fire-building with flint and steel.

Trophies and some cash awards are at stake at the two major matches each year. Food and merchandise prizes are awarded at turkey and beef shoots and other minor matches throughout the year. Approximately 190 charter clubs are affiliated with the national organization and have local shooting matches. This year Hill has established territorial shoots and national courses of fire. Winners in the six designated territories in the United States will compete for national titles.

Four out of five top places were won by women.

Perhaps one of the major reasons muzzle loading is so popular and growing so rapidly is that it is family oriented. Specific events are planned for women and children, although they may compete in any event. Hill notes that in one of the more prestigious all-competitive events at the 1975 national match, four out of the five top places were won by women. Most of the families camp out during the matches which last from 2 to 10 days. There is such a demand for campsites that reservations are required and are usually made a year or more in advance. Hill says there is a lot of visiting, trading, tall-tale swapping, and music around the campgrounds, and square dances are often planned for the group.

It is estimated that as many as 50 percent of the owners of black powder firearms use their rifles and shotguns for game hunting. About 25 of the States now offer special big game hunting seasons and/or areas for muzzle-loaded firearm hunting. A person hunting with a muzzle loader may give way to modern guns for long-range shooting and the rapidity of a second shot, but that is about all. "The one available shot from most muzzle loaders makes a hunter a little more considerate of what he does with that shot," comments Hill.

Hill has used muzzle loaders from his collection to bag deer, squirrel, and duck but admits he sometimes concedes to modern shotguns for the faster bird hunting. Hill's two sons began competitive shooting when they were 6 and 7 years old and have now moved into big game and small game hunting. Both are in the process of building their own muzzle-loading rifles.

In this atomic age, our knowledge of the muzzle-loading era may have diminished significantly. However, in listening to Al Hill relate the excitement surrounding activities of the NMLRA, the enthusiastic glint in his eyes prompts one to search his mind for historic memories. You can almost envision the frontier scouts peering through the early morning gloom, grasping their trusty muzzle loaders in an attitude of readiness.

PUMPED-STORAGE Research

by
James F. LaBounty and
James J. Sartoris

Twin Lakes, Colo., is not only the site of the Bureau of Reclamation's Mt. Elbert Pumped-Storage Powerplant, but also the location of an unusual study. The study, being undertaken by personnel from the Bureau's Division of General Research at the Engineering and Research Center in Denver, involves evaluating the effects of constructing and operating a pumped-storage powerplant on the aquatic environment of Twin Lakes.

Pumped-storage is a method of storing electric power. Water is pumped from a lower to a higher reservoir during the night when power is least needed by customers. During the day, when power demand is highest, water is released back through the plant's generators, producing electricity. Power used during peak demand periods is called "peaking power."

Increasingly, pumped-storage is being used to provide peaking power. However, prior to this study very little had been known about the environmental effects of pumped-storage. Today there is only a handful of such studies in the world, three of which are in the Western United States. In addition to the Twin Lakes study, the other two in the West are at Banks Lake, on the Columbia Basin Project near Grand Coulee, Wash., and on the Salt River reservoirs of Arizona. All three studies are on Bureau of Reclamation projects and are being financed, at least in part, by the Bureau.

The Twin Lakes study is the Bureau's commitment to comply with various laws, such as the National Environmental Policy Act of 1970, that requires protecting and enhancing the environment within project areas.

Twin Lakes was chosen for the montane aquatic study because of its proximity to Denver (and the research laboratory) and because it contains a unique and popular resource—a quality lake trout fishery. Contributing to the successful lake trout fishery is the presence of mysis shrimp, introduced to Twin Lakes by the Colorado Division of Wildlife in 1957. Lake trout, especially the young, thrive on mysis.

The successful mysis-lake trout situation is due to a combination of environmental factors, factors that also make Twin Lakes an ideal study area. Both mysis and lake trout have extremely limited ecological tolerances. Any deviation from a strict norm in their environment will be reflected in reduced population numbers. For example, if the lower lake, where the powerplant is located, became more turbid because the generating flows had stirred up bottom sediments, shrimp populations near the powerplant could de-

James F. LaBounty is a research biologist and James J. Sartoris is a research civil engineer. Both are in the Division of General Research, Engineering and Research Center, Denver, Colo.

cline because of their intolerance of turbidity. And, should fish and/or shrimp get into the pump-generators, the likelihood of their survival is low.

Basically, the objective of the study is to learn what happens at Twin Lakes so its environment can be protected and so that future projects can be planned with a better understanding of environmental impacts.

The objective of the study is to learn what happens at Twin Lakes so its environment can be protected.

Reclamation has been working on the study, in cooperation with the Colorado Division of Wildlife and the U.S. Fish and Wildlife Service, for about 5 years. The pre-operation phase of field work is complete. This phase included collecting weather data at an onsite weather station, where a computer automatically recorded the major weather parameters and reservoir surface elevation on an hourly basis. The lakes were also monitored by data acquisition systems mounted on rafts. These systems automatically recorded average hourly air and water surface temperatures, and wind speeds.

The reservoirs were surveyed by researchers once or twice monthly during the summer and winter. A typical survey included measuring temperature, pH, dissolved oxygen, conductivity, and oxidation-reduction potential profiles; sampling inflow, outflow, and reservoir water for chemical composition; sampling benthic (bottom) mud; collecting benthic and planktonic organisms; and measuring reservoir biological productivity.

Cooperating researchers investigated the numbers and life cycles of the mysis shrimp and lake trout. Divers from the Bureau's Lower Missouri Region Dive Team participated in this phase of the study. Special microbiological and sediment studies were also performed by colleagues from the Lower Colorado Region and the Fish and Wildlife Service.

Twin Lakes, Colo.

The data from the study provide a clear picture of the existing aquatic environmental conditions at Twin Lakes. Following the initiation of the pumped-storage operation in October 1977, field work will be duplicated to detect changes in the Twin Lakes ecosystem.

While gathering routine data, researchers made an important finding at Twin Lakes. Sediments in both the upper and lower lakes contain unusually high

Investigators collect water samples through the ice at Twin Lakes.

amounts of heavy metals exposed from ore bodies on the watershed. During spring runoff, for example, Lake Creek, which feeds Twin Lakes, is red with iron, copper, and other metals. During severe winters, the bottom of the upper lake becomes anaerobic, allowing the accumulated metals to dissolve and create a hostile environment for life in the lake.

Before the turn of the century, Twin Lakes fluctuated little and had a large marshy area at the west end of the upper lake. Since then, the lakes have fluctuated considerably because of the construction of a deeper outlet and the addition of diverted Western Slope water to Lake Creek. Because of this extreme fluctuation, most of the marsh has been scoured out and the organic debris has been deposited on the bottom of the upper lake, where it is undergoing gradual decomposition. Now, during periods of stratification (summer and winter), the demand for oxygen by bacterial organisms in the sediments is high.

The Twin Lakes study is the Bureau's commitment to comply with various laws

The period of stratification during the summer is short and is accompanied by a good flow of colder stream water into the deeper lake layers, replenishing the dissolved oxygen. During winter stratification, which may last 6 months, the story is different. Ice topped with snow precludes light from entering the water. The absence of light stops photosynthesis and hence the

production of oxygen by algae and other aquatic vegetation. At the same time, low winter streamflow into the lake cannot replenish the dissolved oxygen. The oxygen in the lake is gradually exhausted by decomposition of the organic debris in the bottom sediments. The resulting anaerobic condition allows metals in the sediments to move into solution (dissolved form) and upset the ecological balance of the lake.

The data from the study provide a clear picture of the existing aquatic environmental conditions at Twin Lakes.

This situation seems to occur only when the area suffers a severe winter. Ice forms early in the fall, becomes thick and covered with snow, and melts late in the spring. Such a winter occurred during 1974-1975 and the result was a decimation of life in the upper lake.

Historically, the two lakes were ecologically similar, both supporting good trout fisheries. Today, the lower lake is rated as a very good trophy lake trout fishery while the upper is poor. The theory is that the heavy metals problem causes this difference. If the area near the bottom of the upper lake could be prevented from becoming anaerobic, heavy metals would stay in a particulate, nontoxic form.

This winter an experiment is being attempted to remedy the situation. Molecular oxygen is pumped from the surface of the ice to the bottom of the upper lake in the form of very fine, low-energy bubbles that will quickly dissolve into the water. Stratification will remain intact and, hopefully, anaerobiosis will be prevented. If this experiment proves successful, a permanent installation will be recommended.

In time, the upper lake may recover and become, like the lower lake, a good trout fishery. An upper lake fishery would be especially important if the Mt. Elbert Pumped-Storage Powerplant demonstrates an adverse effect on the present fishery in the lower lake.

Twin Lakes is an important resource to the people of Colorado, because of its fishery and the aesthetics of the area. It is essential that, while it is being used to help fulfill the West's needs for power production, it is also being protected for future generations. Ecological studies such as those conducted by the Bureau of Reclamation will help ensure this protection and will provide information to aid in the planning, design, construction, and operation of future pumped-storage facilities.

Mysis Shrimp

Mackinaw Trout from Twin Lakes, Colo.

Yesterday and Today in the ERA

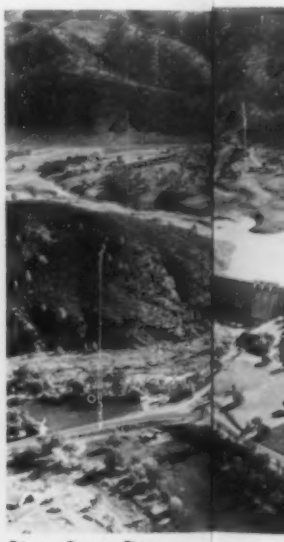
The Orland Project, Calif.

Yesterday—1929

Although native to the countries bordering the Mediterranean Sea, the almond is especially well adapted to California as a whole. Trees grow in nearly every county of the State. The Sacramento and San Joaquin Valleys together with the adjacent foothill areas, however, constitute the major portion of the State's commercial producing area. Almond trees are found in a number of Eastern States, but California produces about 99 percent of the entire crop raised in the United States.

The almond is somewhat similar to the peach in manner of growth and character of blossoms and leaves. The wood, however, is much harder and under similar conditions the tree is much longer lived. The useful life of the almond at Orland is rather indeterminate, there being project orchards 40 to 45 years of age which are still producing profitable crops under proper agricultural methods. A peculiar characteristic of the tree is its very short period of winter dormancy. It is among the last of the deciduous trees to shed its leaves in the fall and the first to start growth and come into bloom in the spring.

Stony Gorge Dam, Orland Project, releases 1,647,659 gallons of water per minute.



Stony Gorge Dam and Reservoir

lifornia produces 99 percent
ll the almonds produced
he United States.

Today

The Orland Project, located in the north-central portion of the Sacramento Valley of California, 100 miles north of Sacramento, produced 68,773 tons of almonds last year and they sold for $987.63 per ton.

The project was built to furnish a full irrigation water supply for 19,811 acres of land. The natural flow of Stony Creek provides sufficient water for the project in normal years until late May, when it is supplemented with water stored in the project's two reservoirs, created by East Park Dam on Little Stony Creek and by Stony Gorge Dam on Stony Creek. There are 39 miles of canals, and the distribution system contains 100 miles of laterals.

Water stored in the East Park and Stony Gorge Reservoirs is released into the natural creek channels as required for irrigation of the project lands. The Rainbow Diversion Dam diverts water from Stony Creek through the East Park Feed Canal to the East Park Reservoir, supplementing the natural flow of water into that reservoir. The Northside Diversion Dam diverts water from Stony Creek into the North Canal for lands lying on the north side of the creek in the vicinity of Orland. The Southside Diversion Dam diverts water from Stony Creek into the South Canal for lands lying on the south side of the river in the vicinity of Orland.

The favorable growing season on the project makes it possible to raise a variety of agricultural products, the principal ones being citrus and deciduous fruits, olives, nuts, alfalfa, pasture, and grains. The lands are divided into 755 irrigated farm units.

East Park and Stony Gorge Reservoir areas provide campgrounds, including trailer space, picnicking areas, swimming, boating, and fishing, primarily for bluegill and largemouth bass.

A Homesteader's Centennial Birthday

Sarah Ann Fleming

by Bob Gilluly

The only surviving homesteader of an earlyday Bureau of Reclamation irrigation settlement on the Sun River Project celebrated her 100th birthday on December 20, 1976.

And, although Sarah Ann Fleming is no longer able to play an active role in farming, it was quite a milestone when the anniversary rolled around. She has lived continuously on a farm south of Fort Shaw, Mont., for the past 66 years, preferring simple rural life in the shadow of massive Shaw Butte to perhaps more comfortable urban surroundings.

She preferred simple rural life in the shadow of massive Shaw Butte.

Up until just a year ago, in fact, she tended to her own needs with only occasional household help. This ended when an arm and hip fracture left her confined —for the most part—to a wheelchair.

Mrs. Fleming was born in Kansas. She spent most of her early life in Missouri and was married to Arthur W. Fleming at Competition, Mo., on January 14, 1894.

In 1900, the family decided to pack up and move to Canada, lured by the opening of new farmlands in Alberta. The trek, completed by covered wagon, took 2½ months and was a lesson in hardship. It was so dry and hot through North Dakota, Mrs. Fleming recalls, that the

Bob Gilluly is a *Great Falls* (Mont.) *Tribune* staff writer.

party could not find water for its horses.

After farming nearly 10 years near Ponoka, Alberta, the Flemings received some literature telling about new irrigated homesteads opening up in central Montana.

Her daughter, Tina Fleming Bateman, remembers how the Bureau of Reclamation published pamphlets about the Fort Shaw Project in such glowing language "that my Father, who had an itching foot anyhow, left Alberta with Mother and the children to find the pot at the end of the rainbow. My mother was homesick and disillusioned at the very sight of the barren prairie inhabited then by coyotes, jackrabbits, and prairie dogs, and also herds of ranchers' cattle which had to be fenced out before a crop could be planted."

The first water was delivered to the Fort Shaw portion of the larger Sun River Irrigation Project in the spring of 1909. Less than a year later, the Fleming family took up its homestead, gaining 61 irrigated acres on one of the 204 farmsites that were available.

The place has been her home ever since.

Mr. Fleming died in the fall of 1950 but his wife carried on and operated the place by herself until the early 1960's. Then, with advancing age, she decided to rent it to her youngest son, Vernon W. Fleming.

Her three living children—Vernon and Tina of Fort Shaw and Walter of Simms, Mont.,—all live close enough to help care for her. Two other children died in infancy and three others passed away in more recent years. She has 13 grandchildren, 23 great-grandchildren and 26 great-great-grandchildren.

Although she's a trifle hard of hearing and now can take only a few steps away from her wheelchair, Mrs. Fleming retains a keen memory. She especially remembers some of her early experiences and hardships.

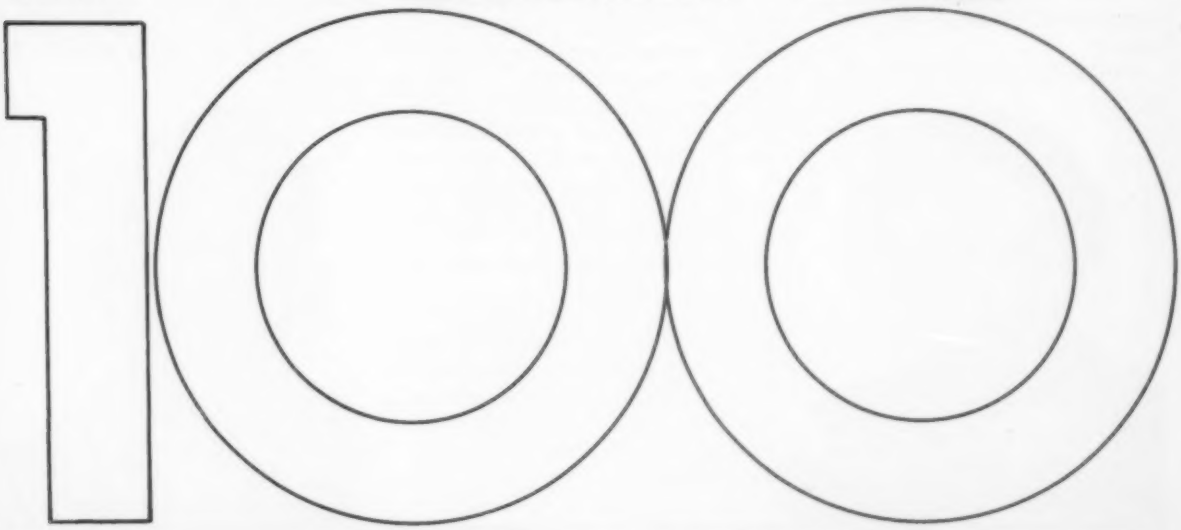
According to her daughter, often it seemed as if Mrs. Fleming survived by sheer willpower and diligent work through the bad times—rabbits and gophers ate the garden, skunks killed the chickens, storms took their toll in livestock and crops. But how she loved her garden. She sold vegetables and berries from plants and trees which she had carefully tended, and which Arthur Fleming had kept irrigated with water from the Reclamation canal. She picked,

She sold vegetables and berries from plants and trees which she had carefully tended.

washed, crated, and hauled to market her produce.

During a recent interview Mrs. Fleming recalled several episodes including the covered-wagon trip to Canada. Somewhere along the route she saw her first motorcar and remembers that her horses were not frightened by the strange machine.

A birthday reception was held in her honor at the Fort Shaw Bible Church.



News Notes

Employees in the News

Hinds Named Water and Land Chief

Eugene Hinds has been named Chief, Division of Water and Land. He succeeded Cliff Barrett who was appointed Assistant Commissioner-Resource Planning.

Hinds began his career with the Bureau of Reclamation at Phoenix in 1961 as an agricultural economist. Later, Hinds became Chief, Division of Economics and Land Resources in San Bernardino, Calif., where he worked for 3 years. In 1966, and for the next 9 years, Hinds served as Chief of the Contract Repayment Division in Boulder, Colo.

Hinds attended Ft. Lewis Jr. College in Durango, Colo., for 2 years and he received a B.S. degree in agriculture from New Mexico State University.

A native of Farmington, N. Mex., Hinds and his wife, Ann McGee, have three daughters, Carrie, Cheryl, and Christi.

Hinds said that his goal as Chief, Division of Water and Land is "primarily to get a teamwork effort going that can accomplish the work."

Distinguished Service Awards Presented

Distinguished Service Awards were presented to three Bureau of Reclamation employees at the Department of the Interior Forty-fourth Honor Awards Convocation Ceremony Dec. 7, 1976. The honorees are James A. Bradley, David L. Crandall, and John J. Walker (retired).

James A. Bradley, Regional Director of the Southwest Regional Office in Amarillo, Tex., has been with Reclamation 28 years.

Bradley was honored "in recognition of his outstanding professional achievements in directing the development and implementation of major power programs for the Bureau of Reclamation."

His work with Reclamation has included: Supervisor of Power in the Southwest Region, Assistant Regional Director in the Upper Missouri Region, and Chief, Division of Power in the Washington Office.

David L. Crandall, Regional Director of the Upper Colorado Regional Office in Salt Lake City, Utah, has been with Reclamation for 30 years.

He was honored "in recognition of his outstanding contributions to the development, implementation, and administration of major Bureau of Reclamation programs in the Upper Colorado Region."

Eugene Hinds

James A. Bradley

Crandall was further cited for "his outstanding ability to negotiate and conclude agreements between and among opposing interests, his considerable expertise in administering a vast water storage program, and his uncommon efforts to achieve compliance with both the spirit and the letter of environmental law which make Crandall a valuable resource at every stage in the development of a project."

John J. Walker was honored "in recognition of his illustrious 30-year career in the engineering and administrative fields with Reclamation."

Walker used his knowledge of steel pipe design to enhance Bureau construction projects. In addition to being recognized for this expertise by his colleagues in the Bureau, he is recognized by peers in the private sector. His work with two congressional committees, which investigated and set steel pipe design standards having worldwide impact, is an indication of the esteem and prestige that he commanded.

Former Assistant Commissioner Dies

Stanley W. Crosthwait, a former Assistant Commissioner for Administration, died December 23. He became Assistant Commissioner in 1954 and held that position until his retirement in 1958.

Crosthwait began his Federal career in 1916 with the Navy Department. He also worked for the Internal Revenue Service, the Department of Commerce, and the National Power Policy Committee before coming to the Bureau of Indian Affairs in the Interior Department. In 1964 he transferred to the Bureau of Reclamation.

Crosthwait served in both World Wars.

Regional Director Jim Bradley Retires

Southwest Regional Director James A. Bradley retired after 28 years of service with the Bureau of Reclamation.

Bradley began his career with Reclamation in 1948 as an electrical engineer with the South Platte River District office in Estes Park, Colo.

In 1956 he transferred to the regional office in Amarillo, Tex. While there, he was promoted to assistant regional supervisor of power and then to regional power supervisor.

David L. Crandall

John J. Walker

Cliff Pugh, "Mr. Central Arizona Project," Retires

Clifford A. Pugh, tagged "Mr. Central Arizona Project" because of his matching initials and his years of work on the CAP, has retired after 42 years of Federal service.

For over 20 years, Pugh headed the Bureau's Phoenix office which is locally responsible for the CAP.

Pugh joined Reclamation in 1934. In 1940 he transferred to the Corps of Engineers. In 1946 he rejoined the Bureau and was area engineer in the Phoenix Development Office from 1951 to 1965.

He was named Assistant Regional Director, stationed in Phoenix in 1965. In 1972 he was appointed manager of the Arizona Projects Office which replaced the Phoenix Development Office. Pugh received the Department's Distinguished Service Award for his work on CAP.

Ted Moser, Yuma Manager, Dies

Theodore (Ted) Moser died January 11. He was the project manager of the Yuma Projects Office (Lower Colorado Region).

Moser had completed 30 years of Federal service. He began his Bureau career in May 1948 in the Kansas River District Office in Indianola, Nebr. He also worked at the Rio Grande Project Office, rising to the position of assistant project manager before transferring to the Yuma Projects office in 1963.

Moser was a registered professional engineer in Arizona, Texas, and New Mexico; a member of the U.S. Committee of the International Commission on Irrigation and Drainage, the American Society of Civil Engineers, the Arizona Society of Professional Engineers, and the National Society of Professional Engineers. He is also listed in the "Who's Who in Engineering."

Shunick Heads Arizona Projects Office

Richard E. Shunick, veteran of 27 years Federal service, has been appointed to manage the Bureau of Reclamation's Arizona Projects Office in Phoenix.

Shunick, Associate Projects

Clifford A. Pugh

Theodore Moser

Richard E. Shunick

Manager from August 1971 until his promotion, succeeds Clifford A. Pugh, who retired in December.

As Arizona Projects Manager, Shunick is directly responsible for construction of the Central Arizona Project's water features. Under construction since 1972, the CAP will deliver Colorado River water from Lake Havasu behind Parker Dam to the Phoenix-Tucson areas for agricultural, municipal, and industrial uses.

A native of Illinois, Shunick graduated from Marquette University, Wis., in 1949 with a B.S. degree in civil engineering. He began his Federal career that year in Boulder City as a hydraulic engineer in the Office of River Control and has been with Reclamation ever since.

He came to Washington, D.C. in 1959 where he worked in the Division of Foreign Activities; the Division of Water and Land, heading the Division's irrigation branch, and later as Assistant Chief of the Division.

Regional Director Manuel Lopez noted that Shunick has received numerous awards and commendations throughout his career.

Shunick resides in Paradise Valley, Ariz., with his wife, Margery Anne, four sons, and one daughter.

Carter Comes to Interior

President Jimmy Carter spoke to Interior employees in the Department of the Interior auditorium, February 18.

Before coming to the auditorium, the President visited the Bureau of Indian Affairs on the fourth floor of the Interior Building where he shook hands and talked with employees who did not have tickets to the auditorium.

During his brief remarks, Carter said, "In the area of water resources, the construction of dams and other projects, I want to be sure that in the future these projects are assessed on the basis of modern economic circumstances and that we inject into the process of authorization for existing and future projects the very important characteristic of conservation and environmental quality."

After his remarks, the President opened the floor to questions. Questions were asked regarding television programs for the deaf, the status of non-Indian employees in the Bureau of Indian Affairs, the new Department of Energy, and the $50 rebate.

Secretary of the Interior Cecil D. Andrus and President Jimmy Carter

President Carter greets Interior employees.

Reclamation Construction in the News

Unique Bridge

The Bureau has approved the preliminary design for a dramatic horizontal arc-shaped bridge that will hang on cables from the steep walls of a 1,400-foot gorge in northern California.

Entitled "Ruck-A-Chucky Bridge," this unique structure will cross the middle fork of the American River where Auburn Dam will create a 450-foot-deep reservoir sometime in the early 1980's. The design calls for a main single span of 1,300 feet, curved on a 1,500-foot radius and suspended by 60 cables anchored into the mountainsides.

The bridge was designed by T. Y. Lin International, San Francisco, and Hanson Engineers, Springfield, Ill. Lin engineers developed the suspended arc concept to avoid extensive and costly cutting or tunneling into the hillsides. Cost of the bridge and its approaches is estimated at $19 million, about $2 million less than a concrete box-girder bridge supported by two deep piers.

Lin reports that the hanging arc will also provide structural advantages against earthquake forces compared to a bridge supported by piers, because of the spread of cables in varying lengths and different directions. The 50-foot-wide deck superstructure will be a constant depth box girder with a trapezoidal cross section. It will carry two traffic lanes, a sidewalk, and a 10-foot-wide equestrian path.

Ruck-A-Chucky Bridge will span American River, Calif.

$11 Million Contract For Stateline Dam

S. J. Groves and Sons Co. of El Cajon, Calif., has been awarded the contract to construct Stateline Dam in Summit County, Utah, and Uinta County, Wyo.

The $11,062,555 contract calls for construction of a rolled earthfill dam approximately 2,800 feet long at the crest. It also calls for construction of two small dikes, a spillway consisting of a glory hole inlet structure, control house, and stilling basin.

Stateline Dam, part of the Lyman Project in Utah and Wyoming, will provide supplementary water to irrigated lands in Wyoming's Bridger Valley, as well as municipal and industrial water supplies for the towns of Lyman, Mountain View, and Fort Bridger.

Stateline Reservoir, to be created by the dam, will store the irrigation water and will provide 1,500 acre-feet of municipal and industrial water for Lyman and Mountain View. The reservoir will also be used for recreation purposes.

Navajo Dam Powerplant and Switchyard

A Reclamation contract for $4,989,908 has been awarded to Jacobsen Construction Co., Inc., of Salt Lake City, Utah, for construction of the Navajo Dam Powerplant and Switchyard.

The Navajo Dam Powerplant will be on the San Juan River at the Navajo Dam, approximately 39 miles east of Farmington, N. Mex., in San Juan County. The powerplant, located at an elevation of approximately 5,700 feet, will furnish a portion of the electrical energy required to pump water from the Main Canal of the Navajo Indian Irrigation Project to the laterals and pipeline distribution systems for delivery to farmlands.

The Bureau of Reclamation contract calls for construction of the powerplant structure, modification of the existing river outlet works, construction of the switchyard and installation of electrical equipment.

*U.S. GOVERNMENT PRINTING OFFICE: 1977 240-962/2 1-3

El Dorado Pipeline and Reservoir

A contract for $4,638,000 has been awarded to Wunschell & Small, Inc., of North Highlands, Calif., for the installation of a pipeline and the construction of a regulating reservoir near Placerville, Calif.

The contract calls for the furnishing and laying of about 14 miles of 18- through 48-inch-diameter pipe; constructing a concrete-lined regulating reservoir, 160 feet long, 110 feet wide, and 23.5 feet deep; repairing road surfacing; erecting chain link fences; and constructing reservoir inlet and outlet structures.

The El Dorado Main No. 2 pipeline and reservoir 2A are part of the Sly Park Unit, American River Division, Central Valley Project. They will supplement the capacity of the El Dorado Irrigation District's existing El Dorado Main.

Fort Thompson Substation Contract

Talon Construction Co., Addison, Tex., has been awarded a $2,847,015 contract for improvements to the Bureau of Reclamation's Fort Thompson power substation near Highmore, S. Dak.

Features of the work include placement of a watertight membrane below the surface of the substation yard to prevent moisture from penetrating and expanding the subsurface soil—a condition which has caused damage to some substation facilities.

Special Issue of *Reclamation Era*

The Bureau of Reclamation will celebrate its 75th anniversary in June 1977. To commemorate this event, a special issue of the Reclamation Era will be offered to the public through the Government Printing Office. Stories about early frontier life on Reclamation projects will be presented. If you have an authentic story in which you think readers of Reclamation Era would be interested, send it as soon as possible to:

Editor, Reclamation Era
U.S. Bureau of Reclamation
18th and C Sts. NW.
Washington, D.C. 20240
or telephone: (202) 343-4662

Up-coming Conferences

"Water Resources Operations Management Workshop"

Sponsored by the Water Resources Planning & Management Division of the Colorado Section of the American Society of Civil Engineers.
Place: Stapleton Plaza Motor Motel, Denver, Colo.

Date April 13-15, 1977

Contact: Richard Lanyon, Metropolitan Sanitation Department of Chicago, 100 E. Erie St., Room 311, Chicago, Ill. 60611. (312) 751-5710

"Second Annual Engineering Mechanics Specialty Conference"

Sponsored by the Engineering Mechanics Division of the North Carolina Section of the American Society of Civil Engineers.
Place: North Carolina State University, Raleigh, N.C.

Date: May 23-25, 1977

Contact: Dr. Donald Dean, Department of Civil Engineering, North Carolina State University, P.O. Box 5993, Raleigh, N.C. 27607. (919) 737-2331

Answers to Water Quiz

1. (B) Yellowstone Canyon
2. (A) True
3. (C) Hunins and Hunic Acids
4. (B) False, two-thirds water
5. (D) All of the above

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